

(12) INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(19) World Intellectual Property Organization
International Bureau(43) International Publication Date
7 June 2001 (07.06.2001)

PCT

(10) International Publication Number
WO 01/41395 A1(51) International Patent Classification⁷: H04L 29/06

SUIHKO, Tapio [FI/FI]; Haltianniitty 3 as 4, FIN-02200 Espoo (FI). ASOKAN, Nadarajah [CA/FI]; Ankurinvarsi 61 C, FIN-02320 Espoo (FI). ALAKOSKI, Timo [FI/FI]; Kylävoudintie 2 B 12, FIN-00640 Helsinki (FI).

(21) International Application Number: PCT/FI00/01043

(74) Agent: KOLSTER OY AB; Iso Roobertinkatu 23, P.O. Box 148, FIN-00121 Helsinki (FI).

(22) International Filing Date:
29 November 2000 (29.11.2000)

(81) Designated States (national): AE, AG, AL, AM, AT, AT (utility model), AU, AZ, BA, BB, BG, BR, BY, BZ, CA, CH, CN, CR, CU, CZ, CZ (utility model), DE, DE (utility model), DK, DK (utility model), DM, DZ, EE, EE (utility model), ES, FI, FI (utility model), GB, GD, GE, GH, GM, HR, HU, ID, IL, IN, IS, JP, KE, KG, KP, KR, KR (utility model), KZ, LC, LK, LR, LS, LT, LU, LV, MA, MD, MG, MK, MN, MW, MX, MZ, NO, NZ, PL, PT, RO, RU, SD, SE, SG, SI, SK, SK (utility model), SL, TJ, TM, TR, TT, TZ, UA, UG, US, UZ, VN, YU, ZA, ZW.

(25) Filing Language: English

(84) Designated States (regional): ARIPO patent (GH, GM, KE, LS, MW, MZ, SD, SL, SZ, TZ, UG, ZW), Eurasian patent (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European

(26) Publication Language: English

(30) Priority Data:
19992560 30 November 1999 (30.11.1999) FI

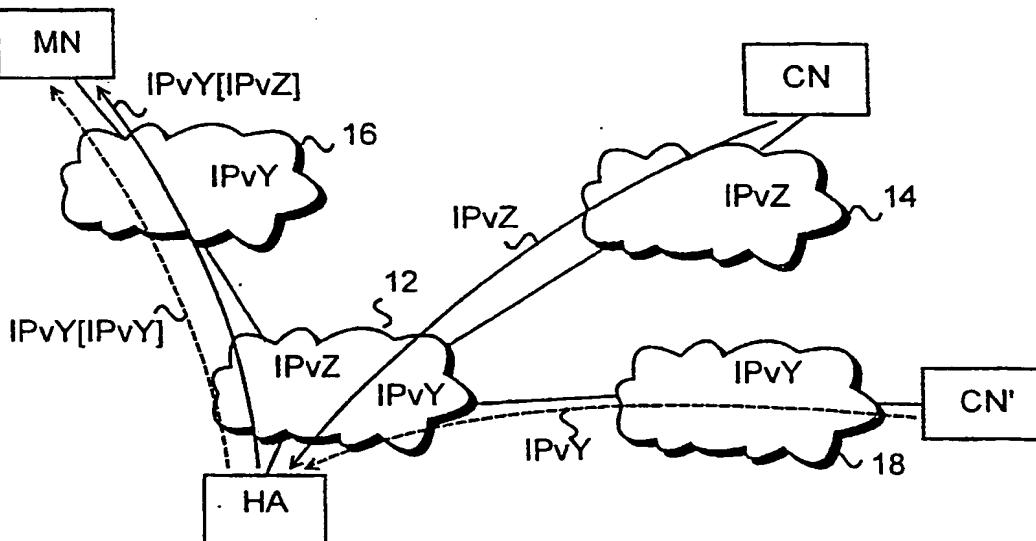
(71) Applicant (for all designated States except US): NOKIA NETWORKS OY [FI/FI]; Keilalahdentie 4, FIN-02150 Espoo (FI).

(72) Inventors; and

[Continued on next page]

(75) Inventors/Applicants (for US only): FLYKT, Patrik [FI/FI]; Silmupolku 1 B 43, FIN-00380 Helsinki (FI).

(54) Title: IP MOBILITY IN A COMMUNICATION SYSTEM



WO 01/41395 A1

(57) Abstract: A method for routing data packets to a mobile node (MN) in a communication system which includes at least a first subnetwork of a first type supporting a first IP version and a second subnetwork of a second type supporting a second IP version. The mobile node (MN) is provided with a set of protocol stacks for handling data packets at least according to the first and the second IP version and with a home address at least according to the first and the second IP version. The home agent (HA) is provided with means for intercepting at least data packets addressed to the mobile node's home address according to the first or the second IP version and for encapsulating a data packet addressed to the mobile node (MN) in a packet according to the IP version of the foreign network (16) to which said mobile node (MN) is attached, for routing the data packet to the mobile node (MN).



patent (AT, BE, CH, CY, DE, DK, ES, FI, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE, TR). OAPI patent (BF, BJ, CF, CG, CI, CM, GA, GN, GW, ML, MR, NE, SN, TD, TG).

— *Before the expiration of the time limit for amending the claims and to be republished in the event of receipt of amendments.*

Published:

— *With international search report.*

For two-letter codes and other abbreviations, refer to the "Guidance Notes on Codes and Abbreviations" appearing at the beginning of each regular issue of the PCT Gazette.

IP mobility in a communication system

Field of the Invention

The invention relates to mobility support of Internet-type protocol traffic in a communication system.

5 Background of the Invention

Originally, Internet Protocol (IP) providing access to the Internet was designed for stationary users. Therefore, the basic IP concept does not support user mobility: The IP addresses are assigned to network interfaces depending on their location in the network. In fact, the first part of an IP address (NETID) is common to all interfaces that are linked to the same Internet subnetwork. This scheme prevents a user (a mobile host) from being reachable while moving over different Internet subnetworks, i.e. while changing the physical interface.

In order to enhance mobility on the Internet, Mobile IPs for IP version 4 (MIPv4) and IP version 6 (MIPv6) have been introduced by the Internet Engineering Task Force (IETF) in the standard RFC2002 and in the Internet Draft "Mobility Support in IPv6", 25 June 1999 (work in progress), respectively. A Mobile IP enables a mobile host to change its point of attachment from one Internet subnetwork to another without changing its IP address. The mobile IP introduces the following new functional or architectural entities. For the sake of brevity, the term 'IP' will hereafter refer to Mobile IP.

A 'Mobile Node' (MN) refers to a host that changes its point of attachment from one network or subnetwork to another. A mobile node may change its location without changing its IP address; it may continue to communicate with other Internet nodes at any location using its (constant) IP address.

A 'Correspondent Node' (CN) refers to a peer node with which a mobile node is communicating. The correspondent node may be either mobile or stationary.

30 A 'Home Network' is the IP network to which a user logically belongs. Physically, it can be, for example, a local area network (LAN) connected via a router to the Internet. A 'Home Address' is an address that is assigned to a mobile node for an extended period of time. It may remain unchanged regardless of where the MN is attached to the Internet. Alternatively, it could be 35 assigned from a pool of addresses.

A 'Home Agent' (HA) is a routing entity that intercepts any packets destined to the mobile node's home address, while the mobile node is away from the home network. The HA encapsulates packets for delivering them to the mobile node, and maintains current location information for the mobile node.

In Mobile IPv4, a 'Foreign Agent' (FA) is a routing entity in a mobile node's visited network, which provides routing services to the mobile node while it is registered in that particular network, thus allowing the mobile node to utilize its home network address. The foreign agent decapsulates the packets that were encapsulated by the mobile node's home agent and delivers them to the mobile node. For datagrams sent by a mobile node, the foreign agent may serve as a default router.

RFC2002 defines a 'Care-of Address' (COA) for Mobile IPv4 as the termination point of a tunnel towards a mobile node for datagrams forwarded to the mobile node while it is away from home. The protocol can use two different types of care-of addresses: a "foreign agent care-of address" is an address announced by a foreign agent with which the mobile node is registered, and a "co-located care-of address" is an externally obtained local address which the mobile node has acquired in the network. An MN may have several COAs at the same time. A COA of a MN is registered with its HA. The list of COAs is updated when the mobile node receives advertisements from foreign agents. If an advertisement expires, its entry or entries should be deleted from the list. One foreign agent can provide more than one COA in its advertisements.

In Mobile IPv6, there is no longer a need to deploy special routers as FAs. Mobile nodes make use of the enhanced features of IPv6 to operate in any location away from home without requiring any special support from their local routers. Most packets sent to a mobile node away from home in Mobile IPv6 are routed using an 'IPv6 Routing' header rather than IP encapsulation, whereas Mobile IPv4 must use encapsulation for all packets. The use of a Routing header requires less overhead for Mobile IP packet delivery from a CN to an MN. To avoid modifying the packet in flight, however, packets intercepted and routed via a mobile node's home agent in Mobile IPv6 must still use encapsulation for delivery. The COA in Mobile IPv6 is the IP address associated with a mobile node while it is visiting a foreign network.

Both in Mobile IPv4 and in Mobile IPv6, the term 'Mobility Binding' is the association of a home address with a care-of address, along with the remaining lifetime of that association. An MN registers its COA with its HA by sending a registration request message. In IPv4, the 'IPv4 Registration Request' message may be relayed to the HA by the foreign agent through which the mobile node is registering, or it may be sent directly to the HA if the mobile node is registering a co-located care-of address. The HA returns an 'IPv4 Registration Reply' message to the mobile node which has sent an IPv4 Registration Request message. If the mobile node has registered by using a foreign agent care-of address, the IPv4 Registration Reply is delivered to the mobile node via the foreign agent. The IPv4 Reply message informs the mobile node about the status of its IPv4 Request. Optional extension fields containing additional information concerning the connection may be included in the IPv4 Registration Request and Reply messages. In IPv6, a mobile node sends a registration request message directly to the HA, and in response to the request message, the HA returns a registration reply message to the mobile node. The registration request and reply messages are included in a 'Destination Options' header, which is used to carry optional information that needs to be examined only by the destination node. The messages are called 'Binding Update' and 'Binding Acknowledge', respectively.

In order to enable full IPv6 functionality of isolated IPv6 nodes in an IPv4 environment, a '6over4' transmission method has been introduced in IETF standard RFC2529. The principle is that IPv6 packets are encapsulated in IPv4 packets for transmission over the IPv4 network between isolated IPv6 nodes.

A real advantage of IPv6 over IPv4 is that the former contains routing optimization by default, i.e. the home agent is involved only when the first datagram is sent to the mobile node on the connection initiation, hence reducing the overhead required. However, an IPv6 network is not available everywhere and not all user terminals are equipped with IPv6 compatibility. Since the addressing schemes in the two versions are incompatible, the IPv4 and IPv6 nodes cannot communicate with each other in a straightforward manner.

Disclosure of the Invention

An object of the invention is to develop a method and a communication system which provide mobile nodes with means for communicating over

networks supporting different IP versions and with means for being simultaneously addressable with IP addresses according to at least two different IP versions irrespective of the type of the particular network that the mobile node is attached to.

5 This object is achieved with a method and a system which are characterized by what is disclosed in the attached independent claims. Preferred embodiments of the invention are disclosed in the attached dependent claims.

According to a preferred embodiment of the present invention, a
10 mobile node is arranged to handle data packets at least according to two different IP versions and to have a home address at least according to said two IP versions. The home agent is provided with means for intercepting all data packets destined to the mobile node irrespective of the original IP version of the data packets. In the home agent, a data packet addressed to the mobile
15 node is encapsulated in a packet according to the IP version of the foreign network with which the mobile node is registered, for routing the data packet to the mobile node. This method improves the employment of the network resources.

According to a further preferred embodiment of the present invention,
20 a mobile node is registered with at least a first and a second foreign network so that the respective first and second care-of addresses are simultaneously active in the home agent of the mobile node, and data packets according to at least the first and the second IP version are routed to the mobile node (MN) via the home agent by using the IP version of the first and the second
25 foreign network respectively. This embodiment can be implemented by means of a new extension field in the registration request message. The advantage of this method is smaller overhead in the visited network.

Brief Description of the Drawings

30 In the following, the invention will be described in greater detail by means of preferred embodiments with reference to the accompanying drawings, in which

Figures 1A and 1B illustrate scenarios where a mobile node in an
35 IPvY foreign network communicates with a correspondent node in an IPvZ subnetwork, Y and Z being different version numbers,

Figures 2A and 2B illustrate scenarios where a mobile node is registered with an IPv4 foreign network,

Figure 3 illustrates a scenario where a mobile node is registered with an IPv6 foreign network,

5 Figure 4 is a signaling diagram illustrating data transfer between an MN in an IPv4 foreign network and a CN in an IPv6 subnetwork,

Figure 5 is a signaling diagram illustrating data transfer between an MN in an IPv6 foreign network and a CN in an IPv4 subnetwork,

10 Figures 6A and 6B illustrate scenarios where a mobile node registers with both IPv4 and IPv6 foreign networks,

Figure 7 is a signaling diagram illustrating the registration of the MN when the MN first registers with an IPv6 foreign network,

Figure 8 is a signaling diagram illustrating the registration of the MN when the MN first registers with an IPv4 foreign network,

15 Figure 9 is a signaling diagram illustrating data transfer when the MN is registered with both IPv4 and IPv6 foreign networks, and

Figure 10 illustrates a registration request message according to the invention.

20 **Detailed Description of the Invention**

The present invention can be generally applied to a network that includes at least two subnetworks supporting different IP versions for providing IP mobility over the subnetworks. The invention can be used especially preferably for providing IP mobility over IPv4 and IPv6 subnetworks. In the following, preferred embodiments of the invention will be described by means of said IP versions without limiting the invention to these particular IP versions.

30 The network may be, for example, a local area network (LAN) or any other kind of network providing data connections. The network may be either wireless or fixed. The greatest advantages are achieved in a network providing a relatively slow data connection. The MN may consist of a laptop computer PC connected to a mobile station radio or some other type of mobile workstation construction. Alternatively, the MN can be an integrated combination of a small computer and a cellular telephone, similar in appearance to the Nokia Communicator 9000 series. Yet further embodiments of the MN are 35 various pagers, remote-control, surveillance and/or data-acquisition devices, etc.

Figures 1A and 1B illustrate simplified scenarios where a mobile node MN is attached to a foreign network 16 supporting IP version Y. A correspondent node CN is attached to a subnetwork 14 supporting IP version Z and another correspondent node CN' is attached to a subnetwork 18 supporting IP version Y. The mobile node MN is provided with a home address according to IP versions Y and Z and with means to handle data packets according to both versions. A home agent HA in said mobile node's MN home network 12 intercepts all packets destined to the mobile node MN regardless of their type and the type of the foreign network with which the mobile node MN is registered.

In Figure 1A, the home agent HA encapsulates an IPvY data packet destined to the mobile node's IPvY home address normally in an IPvY data packet IPvY[IPvY] and an IPvZ data packet destined to the mobile node's IPvZ home address in an IPvY data packet IPvY[IPvZ] for delivery to the mobile node MN. The data packets IPvY[IPvY] and IPvY[IPvZ] are routed directly to the mobile node MN. In Figure 1B, the mobile node MN is registered with the IPvY foreign network via a foreign agent FA and the data packets are routed to the mobile node MN via the foreign agent FA. The home agent HA encapsulates an IPvY data packet destined to the mobile node's IPvY home address normally in an IPvY data packet IPvY[IPvY] for delivery to the mobile node MN via the foreign agent FA. The home agent HA also encapsulates an IPvZ data packet destined to the mobile node's IPvZ home address in an IPvY packet for the mobile node MN and further in another IPvY packet for the foreign agent FA, resulting in a multiply-encapsulated data packet IPvY[IPvY[IPvZ]]. Therefore, both in Figure 1A and in Figure 1B, the correspondent node CN may send data packets according to IP version Z to the mobile node MN without any address transformation, even though the mobile node MN is not attached to a network supporting IP version Z.

Figures 2A, 2B and 3 illustrate simplified scenarios where a mobile node MN and a correspondent node communicate over IPv4 and IPv6 subnetworks. The mobile node MN is provided with means to operate both in IPv4 and IPv6 networks, i.e. to have an IP address according to both protocol versions. In other words, the mobile node MN is always addressable from an external network by both the IPv4 and the IPv6 address. The mobile node's home agent HA in a home network 22 is arranged to intercept IPv4 and IPv6 packets destined to the mobile node MN regardless of their type. In Figures 2A

and 2B, the mobile node MN is attached to an IPv4 foreign network 26 and a correspondent node CNv6 is attached to an IPv6 subnetwork 24.

In Figure 2A, the mobile node MN is registered with the IPv4 foreign network 26 via a foreign agent FA. The home agent HA encapsulates an incoming IPv6 data packet in an IPv4 packet for the mobile node MN and the latter in another IPv4 packet for the foreign agent FA, resulting in a multiply-encapsulated data packet IPv4[IPv4[IPv6]]. In Figure 2B, the mobile node MN is registered with the IPv4 foreign network without a foreign agent FA. The home agent HA encapsulates an incoming IPv6 data packet in an IPv4 packet for the mobile node MN, resulting in a data packet IPv4[IPv6].

In Figure 3, the mobile node MN is attached to an IPv6 foreign network 36 and a correspondent node CNv4 is attached to an IPv4 subnetwork 34. The home agent HA encapsulates an incoming IPv4 data packet in an IPv6 packet for the mobile node MN, resulting in a data packet IPv6[IPv4].

Figure 4 is a signaling diagram illustrating data transfer in a scenario according to Figure 2A. Prior to the data transfer, the mobile node MN registers normally with the IPv4 foreign network. All IPv4 data packets destined to the mobile node MN are routed normally according to the Mobile IPv4 and therefore are not considered here. In step 4-1, the correspondent node CNv6 sends an IPv6 data packet to the mobile node's MN IPv6 address. The home agent HA intercepts the packet and encapsulates it in an IPv4 packet for the mobile node MN and the latter in another IPv4 packet for the foreign agent FA, resulting in a multiply-encapsulated packet IPv4[IPv4[IPv6]] in step 4-2. The foreign agent FA then decapsulates the outer IPv4 packet and forwards the remaining data packet IPv4[IPv6] to the mobile node MN in step 4-3. In the mobile node MN, the remaining IPv4 packet is decapsulated by an IPv4 stack and the original IPv6 packet is forwarded to an IPv6 stack for normal processing in step 4-4. In the other direction, the IPv6 stack in the mobile node MN produces an IPv6 datagram and forwards it to the IPv4 stack in step 4-5. In step 4-6, the IPv4 stack encapsulates the original IPv6 packet into an IPv4 packet and sends the resulting packet IPv4[IPv6] for example to the home agent HA that decapsulates the IPv4 packet and forwards the original IPv6 packet to the correspondent node CNv6 in step 4-7.

Figure 5 is a signaling diagram illustrating data transfer in a scenario according to Figure 3. Now the mobile node MN registers with the IPv6 foreign network in a normal way, and all IPv6 data packets destined to the

mobile node's MN IPv6 home address are routed normally. In step 5-1, the correspondent node CNv4 sends a data packet IPv4 to the mobile node's MN IPv4 address. The home agent HA intercepts the packet and encapsulates it in an IPv6 packet for the mobile node MN, resulting in a packet IPv6[IPv4] in step 5-2. In the mobile node MN, the IPv6 packet is then decapsulated by an IPv6 stack and the original IPv4 packet is forwarded to an IPv4 stack for normal processing in step 5-3. In the other direction, the IPv4 stack in the mobile node MN produces an IPv4 datagram and forwards it to the IPv6 stack in step 5-4. In step 5-5, the IPv6 stack encapsulates the original IPv4 packet into an IPv6 packet and sends the resulting packet IPv6[IPv4] for example to the home agent HA that decapsulates the IPv6 packet and forwards the original IPv4 packet to the correspondent node CNv4 in step 5-6.

Instead of routing MN-originated packets via the HA (steps 4-6 and 5-5), such packets may be routed via any other router or entity that is 15 equipped with means to identify, decapsulate and forward a packet.

Figures 6A and 6B illustrate scenarios according to a further embodiment of the invention. The mobile node MN is registered simultaneously with an IPv4 foreign network 64 and an IPv6 foreign network 66. If both types of foreign networks are available, the mobile node MN retains its attachment 20 to the foreign network it has already registered with and registers also with the other one. Similarly to the scenarios in Figures 2A, 2B and 3, the home agent HA intercepts all packets IPv4, IPv6 destined to the mobile node MN regardless of their type. In Figure 6A, the mobile node MN is registered with the IPv4 foreign network via a foreign agent FA. The home agent HA encapsulates an 25 IPv4 datagram in an IPv4 packet IPv4[IPv4] for the foreign agent FA, which forwards the original IPv4 packet to the mobile node MN. Correspondingly, the home agent HA encapsulates an IPv6 datagram in an IPv6 packet IPv6[IPv6] for the mobile node MN. In Figure 6B, the mobile node MN is registered with the IPv4 foreign network without a foreign agent FA. Now the home agent HA 30 encapsulates an IPv4 datagram in an IPv4 packet IPv4[IPv4] directly for the mobile node MN. Similarly to Figure 6A, the home agent HA encapsulates an IPv6 datagram in an IPv6 packet IPv6[IPv6] for the mobile node MN. In this way, unnecessary encapsulations are eliminated and overhead for the foreign networks is reduced.

35 Figure 7 is a signaling diagram illustrating the registration of the mobile node MN in a scenario according to Figure 6A when the mobile node

MN first registers with the IPv6 foreign network. Steps 7-1 and 7-2 illustrate normal registration with the IPv6 foreign network. Steps 7-3 to 7-6 illustrate registration with the IPv4 foreign network via a foreign agent with a 'Simultaneous IPv6 Binding' extension. The extension is similar to for example 5 the 'Encapsulating Delivery Style' extension header and includes the IPv6 care-of address that will be used simultaneously with the IPv4 care-of address.

Figure 8 is a signaling diagram illustrating the registration of the mobile node MN in a scenario according to Figure 6A when the mobile node 10 MN first registers with the IPv4 foreign work. Steps 8-1 to 8-4 illustrate normal registration with the IPv4 foreign network via a foreign agent. Steps 8-5 and 8-10 6 illustrate the registration with the IPv6 foreign network with a 'Simultaneous IPv4 Bindings Destination Option' extension including the IPv4 care-of address that will be used simultaneously with the IPv6 care-of address.

In Figure 9, data transfer in a scenario according to Figure 6A is 15 illustrated in the form of a signaling diagram. The correspondent node CNv6 sees the mobile node MN as an IPv6 node and the correspondent node CNv4 sees the mobile node MN as an IPv4 node. Steps 9-1 to 9-5 illustrate traffic between the correspondent node CNv6 and the mobile node MN and steps 20 9-6 to 9-9 illustrate traffic between the correspondent node CNv4 and the mobile node MN.

Figure 10 illustrates a registration request message 101 according to the present invention used for simultaneous registration with an IPv4 and an IPv6 foreign network. The first part 102 of the message 101 is a normal registration request. In Mobile IPv4, the part 102 is called an IPv4 Registration Request message, and in Mobile IPv6 said part 102 is called a Binding Update 25 and is included in a Destination Options header. The second part 103 of the message 101 is an extension including the care-of address which is to be used simultaneously with the care-of address according to the first part 102 of the message 101.

30 This description only illustrates the preferred embodiments of the invention. The invention is not, however, limited to these examples, but it may vary within the scope and spirit of the appended claims.

Claims

1. A method for routing data packets to a mobile node (MN) in a communication system which includes at least a first subnetwork of a first type supporting a first IP version and a second subnetwork of a second type supporting a second IP version, the method comprising the steps of

5 attaching the mobile node (MN) to a foreign network of the first type (16, 26, 36, 64, 66);

registering the mobile node's (MN) care-of address in the foreign network (16, 26, 36, 64, 66) with a home agent (HA) located in said mobile 10 node's home network (12, 22);

characterized by

providing the mobile node (MN) with a set of protocol stacks for handling data packets at least according to the first and the second IP version;

15 providing the mobile node (MN) with a home address at least according to the first and the second IP version;

providing the home agent (HA) with means for intercepting at least data packets addressed to the mobile node's home address according to the first or the second IP version; and

20 encapsulating in the home agent (HA) a data packet addressed to the mobile node (MN) in a packet according to the IP version of the foreign network (16, 26, 36, 64, 66) to which said mobile node (MN) is attached, for routing the data packet to the mobile node (MN).

2. A method according to claim 1, characterized by

25 attaching the mobile node (MN) at least to a foreign network of the second type (66, 64);

registering at least the mobile node's (MN) care-of address in the foreign network of the second type (66, 64) with the home agent (HA), so that the care-of addresses at least in the foreign networks of the first and the second type are simultaneously active in the home agent (HA) of said mobile 30 node (MN); and

35 encapsulating in the home agent (HA) at least a data packet addressed to the mobile node's home address according to the first IP version in a data packet according to the first IP version, and a data packet addressed to the mobile node's home address according to the second IP version in a data packet according to the second IP version, for routing the data packets to the mobile node (MN).

3. A method according to claim 2, characterized in that registering the mobile node (MN) with the foreign network of the second type (66, 64) is accomplished by using a registration request message (101) which includes an extension containing at least the care-of address of the mobile node 5 (MN) in said foreign network of the first type (64, 66).

4. A method according to any one of the preceding claims, characterized in that the first IP version is IPv4 and the second IP version is IPv6.

5. A method according to any one of claims 1 to 3, characterized in that the first IP version is IPv6 and the second IP version is IPv4.

6. A communication system for routing data packets to a mobile node (MN), the system comprising

at least a first subnetwork of a first type supporting a first IP version and a second subnetwork of a second type supporting a second IP version, 15 wherein the first subnetwork is the mobile node's foreign network (16, 26, 36, 64, 66);

a home agent (HA) located in the mobile node's (MN) home network (12,22), for registering the mobile node's (MN) care-of address in the foreign network (16, 26, 36, 64, 66);

20 characterized in that

the system is adapted to provide the mobile node (MN) with a home address at least according to the first and the second IP version; and

the home agent (HA) is adapted

25 (a) to intercept at least data packets addressed to the mobile node's (MN) home address according to the first or the second IP version; and

(b) to encapsulate a data packet addressed to the mobile node (MN) in a packet according to the IP version of the foreign network (16, 26, 36, 64, 66) to which the mobile node (MN) is attached, for routing the data packet to the mobile node (MN).

30 7. A communication system according to claim 6, characterized in that

the home agent (HA) is further adapted

35 to accept a registration of at least a second care-of address of the mobile node in a foreign network of the second type (64), so that the care-of addresses at least in the foreign networks of the first and the second type are simultaneously active in the home agent (HA); and

to encapsulate at least a data packet addressed to the mobile node's home address according to the first IP version in a data packet according to the first IP version, and a data packet addressed to the mobile node's home address according to the second IP version in a data packet according to the second IP version, for routing the data packets to the mobile node (MN).

8. A home agent (HA) for routing data packets to a mobile node (MN) in a communication system which includes at least a first subnetwork of a first type supporting a first IP version and at least a second subnetwork of a second type supporting a second IP version, the home agent (HA) being

located in the mobile node's (MN) home network (12, 22); and arranged to accept a registration of the mobile node's first care-of address in a foreign network of the first type (16, 26, 36, 64, 66) to which the mobile node (MN) is attached;

15 characterized in that the home agent (HA) is arranged to cooperate with a mobile node (MN) which is provided with

(a) a set of protocol stacks for handling data packets at least according to the first and the second IP version, and

20 (b) a home address at least according to the first and the second IP version;

is provided with means for intercepting at least data packets addressed to the mobile node's (MN) home address according to the first or the second IP version; and

25 is arranged to encapsulate a data packet addressed to the mobile node (MN) in a packet according to the IP version of the foreign network (16, 26, 36, 64, 66) to which said mobile node (MN) is attached, for routing the data packet to the mobile node (MN).

9. A home agent (HA) according to claim 8, characterized in

30 that the home agent (HA) is arranged to

accept a registration of the mobile node's second care-of address in a foreign network of the second type (66, 64), so that the care-of addresses at least in the foreign networks of the first and the second type are simultaneously active in the home agent (HA); and to

35 encapsulate at least a data packet addressed to the mobile node's home address according to the first IP version in a data packet according to

the first IP version, and a data packet addressed to the mobile node's home address according to the second IP version in a data packet according to the second IP version, for routing the data packets to the mobile node (MN).

10. A mobile node (MN) for a communication system which includes
5 at least a first subnetwork of a first type supporting a first IP version and at least a second subnetwork of a second type supporting a second IP version, the mobile node (MN) being arranged to
attach to a foreign network of the first type (16, 26, 36, 64, 66); and to
10 register its care-of address in the foreign network (16, 26, 36, 64, 66) with a home agent (HA) located in said mobile node's (MN) home network (12, 22);
characterized in that the mobile node (MN) is provided with a set of protocol stacks for handling data packets at
15 least according to the first and the second IP version; provided with a home address at least according to the first and the second IP version; arranged to attach at least to a foreign network of a second type (66, 64);
20 arranged to register a care-of address in the foreign network of the second type (64) with the home agent (HA), so that the care-of addresses at least in the foreign networks of the first and the second type are simultaneously active in the home agent (HA) of the mobile node; arranged to cooperate with the home agent (HA) which is provided
25 with means for intercepting at least data packets addressed to the mobile node's home address according to the first or the second IP version; and arranged to cooperate with the home agent (HA) which encapsulates at least a data packet addressed to the mobile node's home address according to the first IP version in a data packet according to the first IP version,
30 and a data packet addressed to the mobile node's home address according to the second IP version in a data packet according to the second IP version, for routing the data packets to the mobile node (MN).
11. A registration request message (101) comprising
a first part (102) for registration of a mobile node's (MN) second
35 care-of address in a foreign network of a second type (66, 64);

characterized in that the registration request message further comprises

5 a second part (103) including a care-of address of the mobile node in a foreign network of a first type (64, 66) to which the mobile node (MN) has attached prior to attaching to the foreign network of the second type (66, 64).

1/6

Fig 1A

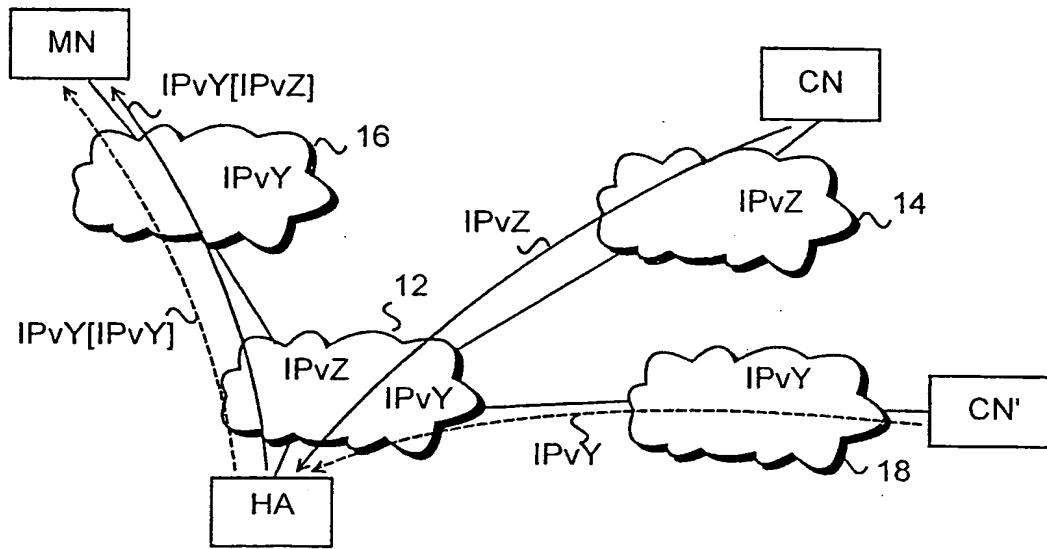
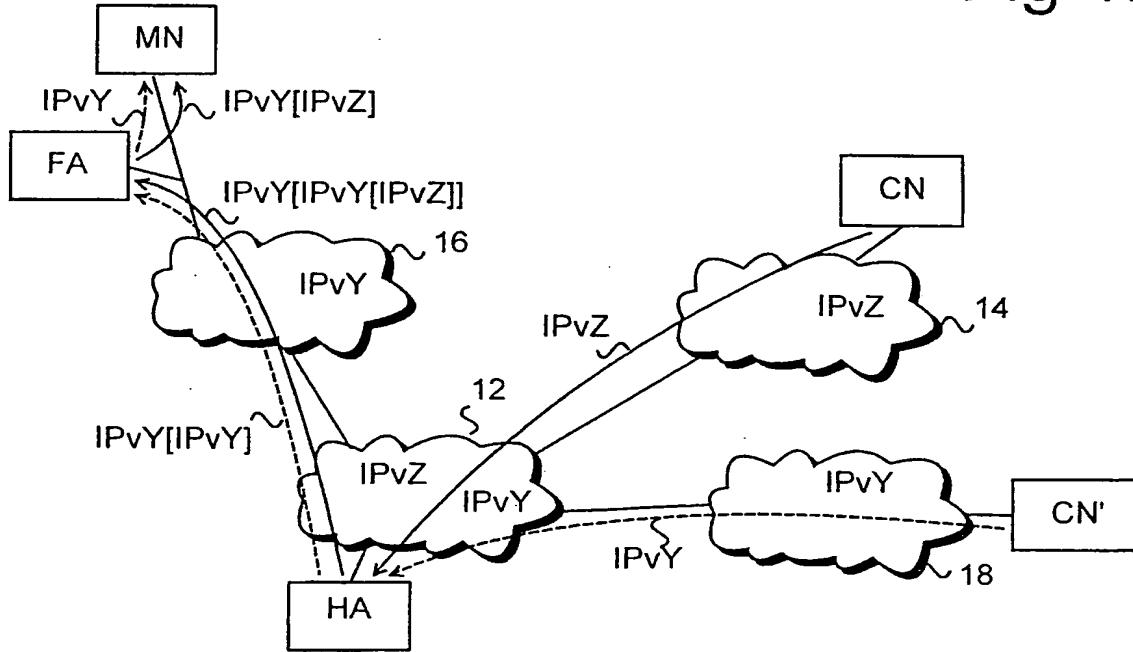


Fig 1B



2/6

Fig 2A

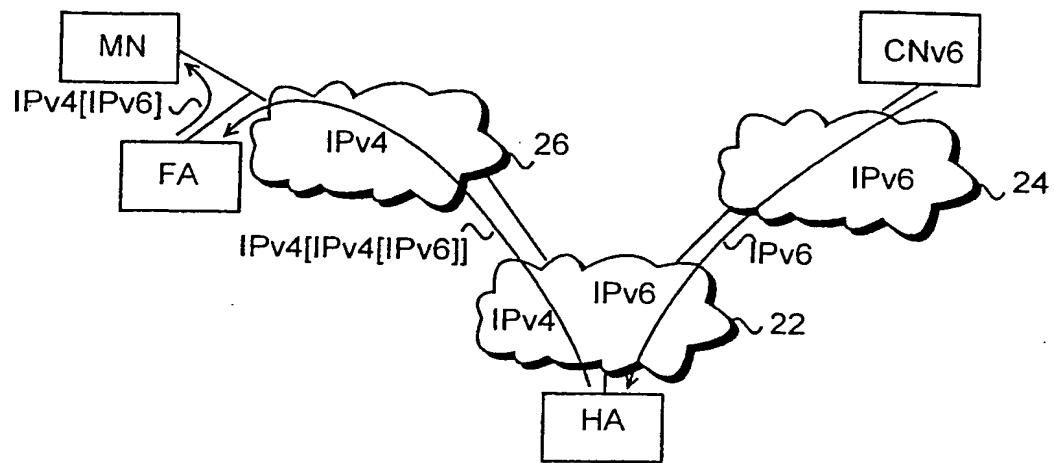
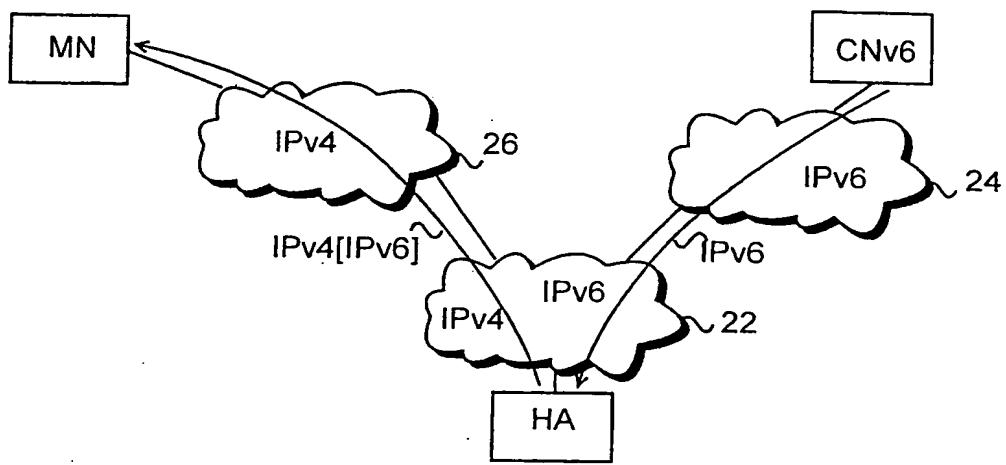


Fig 2B



3/6

Fig 3

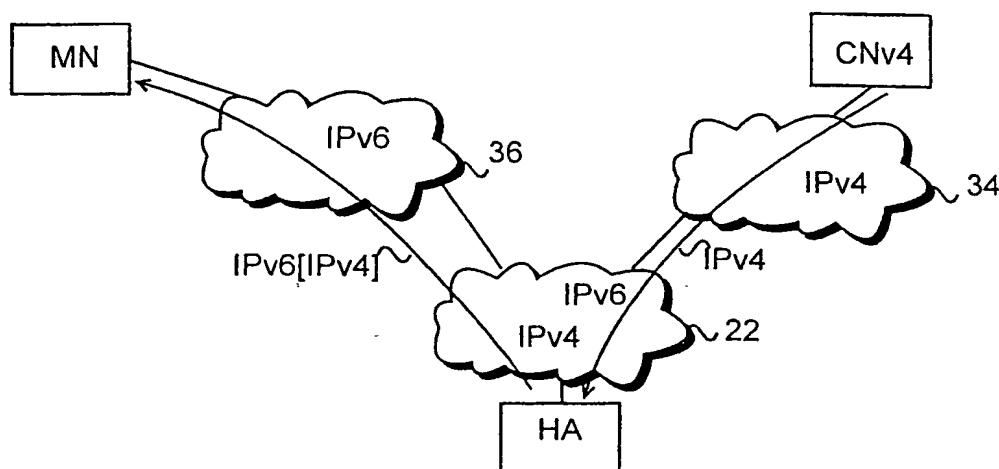


Fig 4

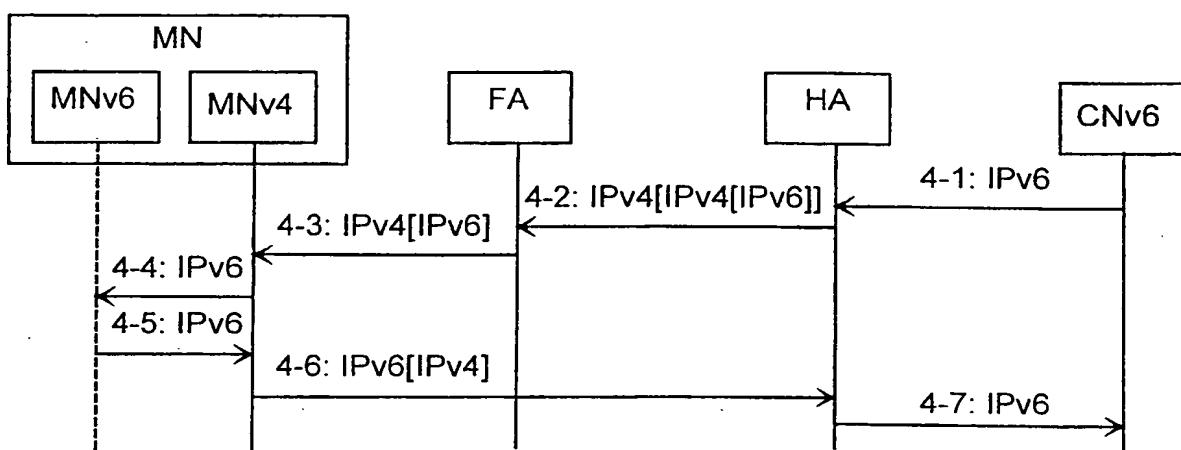
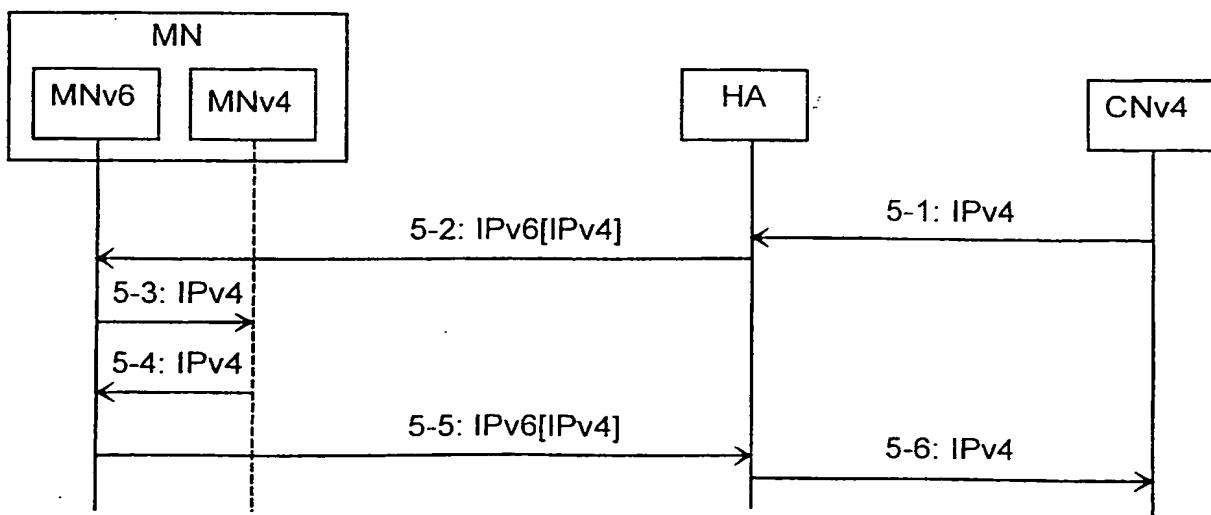


Fig 5



4/6

Fig 6A

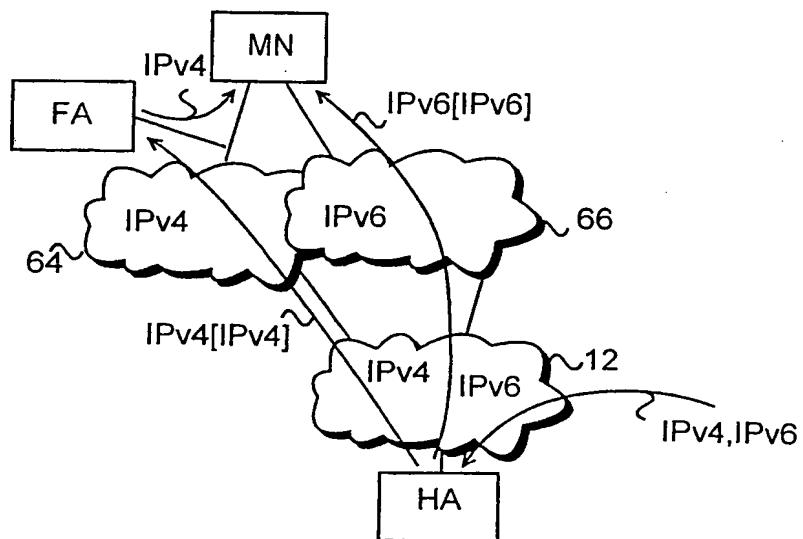


Fig 6B

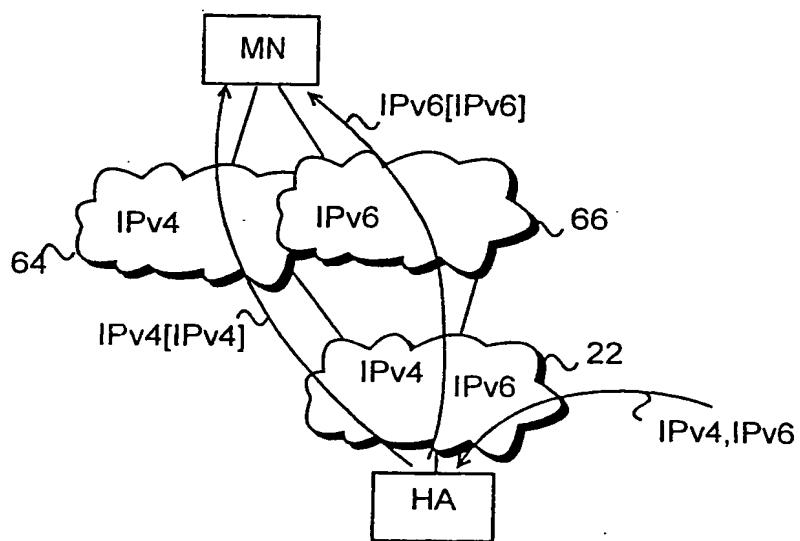


Fig 7

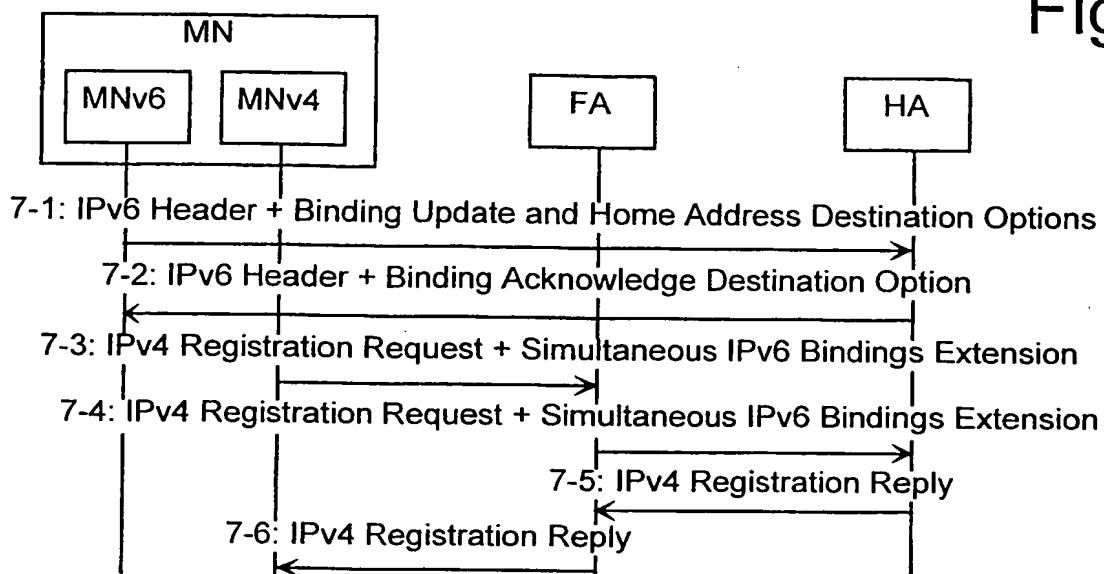
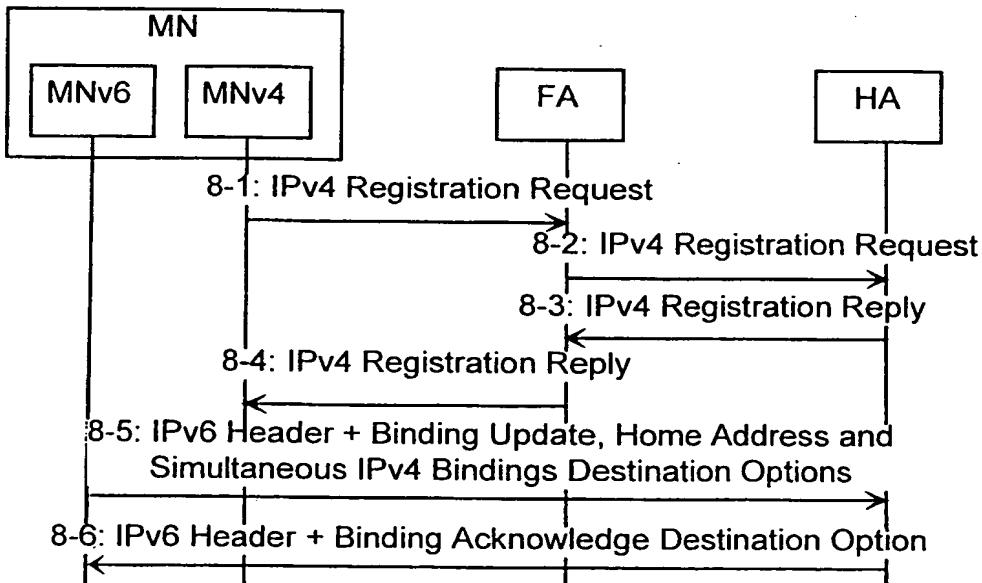


Fig 8



6/6

Fig 9

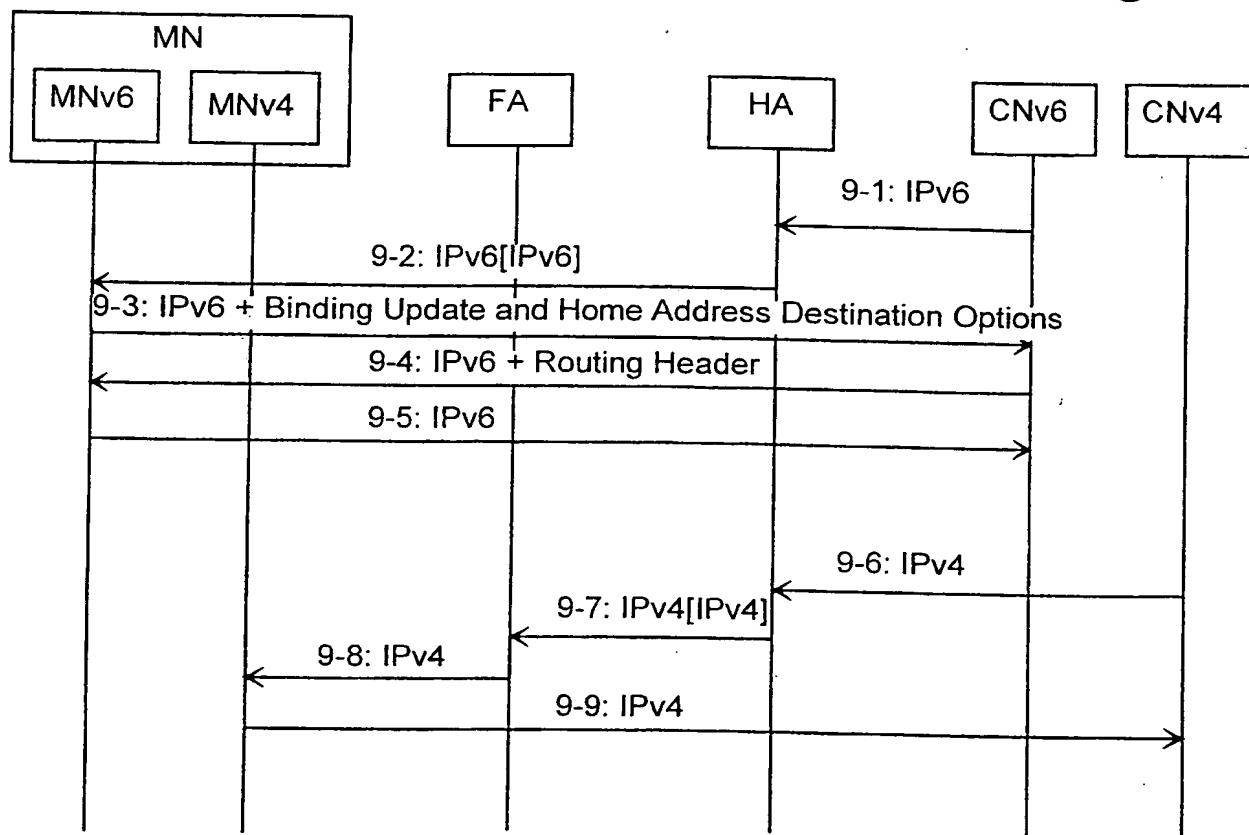
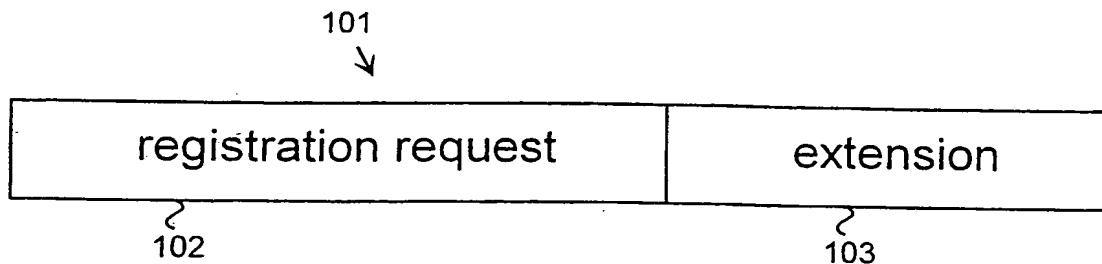


Fig 10



INTERNATIONAL SEARCH REPORT

International application No. PCT/FI 00/01043
--

A. CLASSIFICATION OF SUBJECT MATTER

IPC7: H04L 29/06

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC7: H04L

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

SE,DK,FI,NO classes as above

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	CA 2237370 A1 (WATANUKI, T. ET AL), 13 November 1998 (13.11.98), claims, abstract --	1-11
A	PERKINS, C.E.: Mobile Networking through Mobile IP. In: IEEE Internet Computing, Jan.-Feb. 1998, vol.2, Issue 1; pages 58-69. --	1-11
A	WO 9959363 A1 (CARNEGIE MELLON UNIVERSITY), 18 November 1999 (18.11.99), page 8, line 5 - line 15; page 12, line 3 - page 13, line 17; page 15, line 3 - page 16, line 1 -- -----	1-11

 Further documents are listed in the continuation of Box C. See patent family annex.

* Special categories of cited documents	"I" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
"A" document defining the general state of the art which is not considered to be of particular relevance	"X" document of particular relevance: the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
"I;" earlier application or patent but published on or after the international filing date	"Y" document of particular relevance: the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)	"&" document member of the same patent family
"O" document referring to an oral disclosure, use, exhibition or other means	
"P" document published prior to the international filing date but later than the priority date claimed	

Date of the actual completion of the international search

6 April 2001

Date of mailing of the international search report

09-04-2001

Name and mailing address of the ISA/
Swedish Patent Office
Box 5055, S-102 42 STOCKHOLM
Facsimile No. +46 8 666 02 86Authorized officer
Kristoffer Ogebjörn/LR
Telephone No. +46 8 782 25 00

INTERNATIONAL SEARCH REPORT

Information on patent family members

25/02/01

International application No.

PCT/FI 00/01043

Patent document cited in search report	Publication date	Patent family member(s)		Publication date
CA 2237370 A1	13/11/98	JP	10313336 A	24/11/98
		JP	11068850 A	09/03/99
WO 9959363 A1	18/11/99	AU	3895199 A	29/11/99
		AU	4208699 A	13/12/99
		GB	0023150 D	00/00/00
		GB	2352137 A	17/01/01
		WO	9961968 A	02/12/99